U.S. Mines, Bureau of

Bulletin 76

DEPARTMENT OF THE INTERIOR
FRANKLIN K. LANE, SECRETARY
BUREAU OF MINES
VAN. H. MANNING, DIRECTOR

UNITED STATES COALS AVAILABLE FOR EXPORT TRADE

BY

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Revised edition. August, 1916.
First edition issued in September, 1914.

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UNITED STATES COALS AVAILABLE FOR EXPORT TRADE.

By Van. H. Manning.

INTRODUCTION.

Chemical and physical tests of coals for the use of the Government have been made by the United States Bureau of Mines. These tests form part of a general study of the coals in the United States with respect to the manner in which each coal can be utilized most efficiently. As a result of this study, much information of value to all industries using coal has been compiled.

Special investigations by the Bureau of Mines of the fuels used by the Government have, until recently, been for the most part limited to coal. In the course of these investigations the bureau has developed new methods for use in the purchase of coal by the Government. The application of these methods permits an intelligent selection of the coal adapted to the requirements of particular heating or power plants, and has already resulted in the saving of large sums of money. In addition, these investigations have led to the compiling of a series of carefully made analyses of samples of coal collected in a predetermined manner in the mines of all the important coal fields in the United States, and these analyses are being published to enable Government purchasing agents and all users of coal to select the coal best suited to their needs.

The purpose of this paper is tc describe briefly the general character and commercial quality of some of the coals mined in the United States that reach tidewater shipping ports, and to show in a general way the important characteristics of those coals that by reason of transportation facilities and the situation of the coal fields are most available for export.

Coals of excellent physical character and of high heating value are available for export. For this reason and because of the modern facilities at the collieries for properly grading large shipments, American producers can supply coals suitable for any kind of service. The transportation system from the mines to tidewater and the coal-handling equipment for loading boats at the various ports are highly developed, so that producers are able to give excellent service to foreign buyers. Enormous quantities of these coals have been used by railroads, manufacturing, illuminating-gas, and coke plants, and seagoing vessels, and for household purposes. Much of the coal available for export is superior to the coals that have been supplied to foreign users from other sources.

The coals available for export can best be described by stating their physical characteristics, the uses to which they are well adapted, and their composition as shown by analysis.

INTERPRETATION OF ANALYSES.

In making a comparison of different coals it is essential that the composition of each coal, as shown by analysis, be stated on the same basis. For example, the results may be computed on an "as-received" basis, whereby any chance moisture in the sample is included in the total weight. Analyses on this basis show the quality of the coal actually received by the buyer, but include variations due to any changes in moisture content during transit, and the analyses show correspondingly low heating values. Results computed on a "moisture-free" or "dry-coal" basis show higher but more consistent values for the deliveries of a given coal.

Samples of coal taken from the face in a mine are apt to show higher values than do samples taken from commercial deliveries of the same coal, because impurities associated with the coal in the bed are not likely to be rejected by the miner in the same manner as they are rejected in taking a mine sample. It is evident that analyses representing many shipments and a large tonnage more truly indicate the general quality of the coal that a buyer may expect to receive than does a single analysis from a specially prepared shipment.

The analyses given in this paper represent commercial deliveries of large tonnages and are expressed on a "dry-coal" basis. Each analysis shows three constituents, which are taken to total 100 per cent. These constituents are volatile matter, fixed carbon, and ash.

The "volatile matter" indicates the amount of gas that is produced when the coal is heated and the material that burns in the combustion space above the fire bed rather than on the grate. The "smokeless" coals are among those having a low percentage of volatile matter. Most of the long-flame coals have a high volatile-matter content.

The "fixed carbon" represents that part of the coal that is burned on the grate. The slower-burning coals are among those having a high percentage of fixed carbon.

The "ash" is the incombustible residue left from complete combustion of the coal. This material has no heating value, and the degree to which it impairs the quality of the fuel depends on its behavior, especially its fusibility, in the furnace quite as much as on its amount.

The percentage of "sulphur" is separately determined, and is expressed on the "dry-coal" basis. The percentage of sulphur indicates the suitability of the coal for special purposes, such as for the manufacture of gas and of metallurgical coke. The percentage of sulphur does not necessarily indicate the behavior of the coal in the furnace for the production of steam as regards clinkering. In fact, there may be no more difficulty from clinker in burning the higher than the lower sulphur coals of the United States.

The "moisture" is expressed as a percentage of the weight of the fuel "as received," and depends on the actual moisture content of the coal as influenced by the amount gained or lost during transportation.

The heating value, in British thermal units and in calories, is expressed on a "dry-coal" basis, as are the analytical results. The figures indicate the potential ability of the fuel to generate heat. The actual realization of the potential heating value of any fuel depends upon the adaptation of the furnace to the fuel and the skill with which the fires are handled.

Coals of the best physical character with a small percentage of infusible ash require little skill to be made to yield a high percentage of the potential heating value, whereas inferior coals can be made to produce efficient results with added skill and suitable equipment.

RANGE OF HARDNESS AND OTHER PHYSICAL PROPERTIES OF AVAILABLE COALS.

It is desirable that coals that must be handled a number of times during shipment from the mine to the consumer should not be friable, in order that breakage may be minimized.

The coals here described vary considerably in hardness, in ratio of volatile content to fixed carbon, and in heating value. Some of the principal steam coals available for export can be supplied of a size such that about 50 per cent will pass over a 1-inch bar screen. Such coals (over a 1-inch bar screen) have an ash content of 4.5 per cent and a heating value of 15,000 British thermal units (8,335 calories).

Other coals can be supplied of a size such that about 75 per cent will pass over a 2-inch bar screen. These coals have an ash content of 9 per cent and a heating value of about 13,000 British thermal units (7,225 calories).

CLASSIFICATION OF AVAILABLE COALS BY SHIPPING PORTS.

As the coals shipped from any one port have a general similarity, the coals mentioned in this report have been grouped, for ease of description, according to the ports from which shipment would naturally be made.

No mention is made of the anthracite coals of Pennsylvania because of the tidewater selling prices of those coals being decidedly higher than those of the coals mentioned.

COALS AVAILABLE FOR EXPORT TRADE.

The map (Pl. I) shows those coal-mining districts of the United States from which coal is most likely to be shipped over sea. The coal regions have been divided approximately into fields that, under present conditions, are tributary to the several ports. These boundaries are to be taken only in a general way as the limits of the several fields, and the grouping of the coals within these boundaries is purely arbitrary.

The analytical results show the general type of coal for each of the fields, and can not of course represent the great variety of coals found in some districts. For detailed information regarding the coals of the United States reference should be made to publications of the Bureau of Mines.[a]

GROUP 1. POCAHONTAS AND NEW RIVER COALS.

SHIPPING PORTS: NORFOLK AND NEWPORT NEWS.

Group 1 includes coals from the Pocahontas and New River fields which are loaded for export at Norfolk or Newport News, Va. Shipping facilities from the mines to tidewater are furnished by three railroads. Loading facilities at tidewater are the largest on the Atlantic coast. The ports are open throughout the year, and about 20 large ships can be coaled at one time. Export shipments of these coals are already large.

The quality of Pocahontas coal is shown by the following average analysis:

Average analysis of dry Pocahontas coal.

	Per cent.
Volatile matter	17. 0
Fixed carbon	76. 5
Ash	6. 5
	100. 0
Sulphur	0. 65
Moisture (coal as received)	2. 50

Heat value, 14,700 B. t. u. (8,170 calories).

From some parts of the Pocahontas field the coal delivered shows as high as 15,000 British thermal units (8,335 calories) and an ash content as low as 4.5 per cent, and from other parts of the field it yields 14,500 British thermal units (8,060 calories) and contains 8 per cent ash. These figures may be considered as representing the reasonable limits for commercial deliveries.

Some of the New River coals show heating values of 15,100 British thermal units (8,390 calories) and 3.5 per cent ash, and some 14,600

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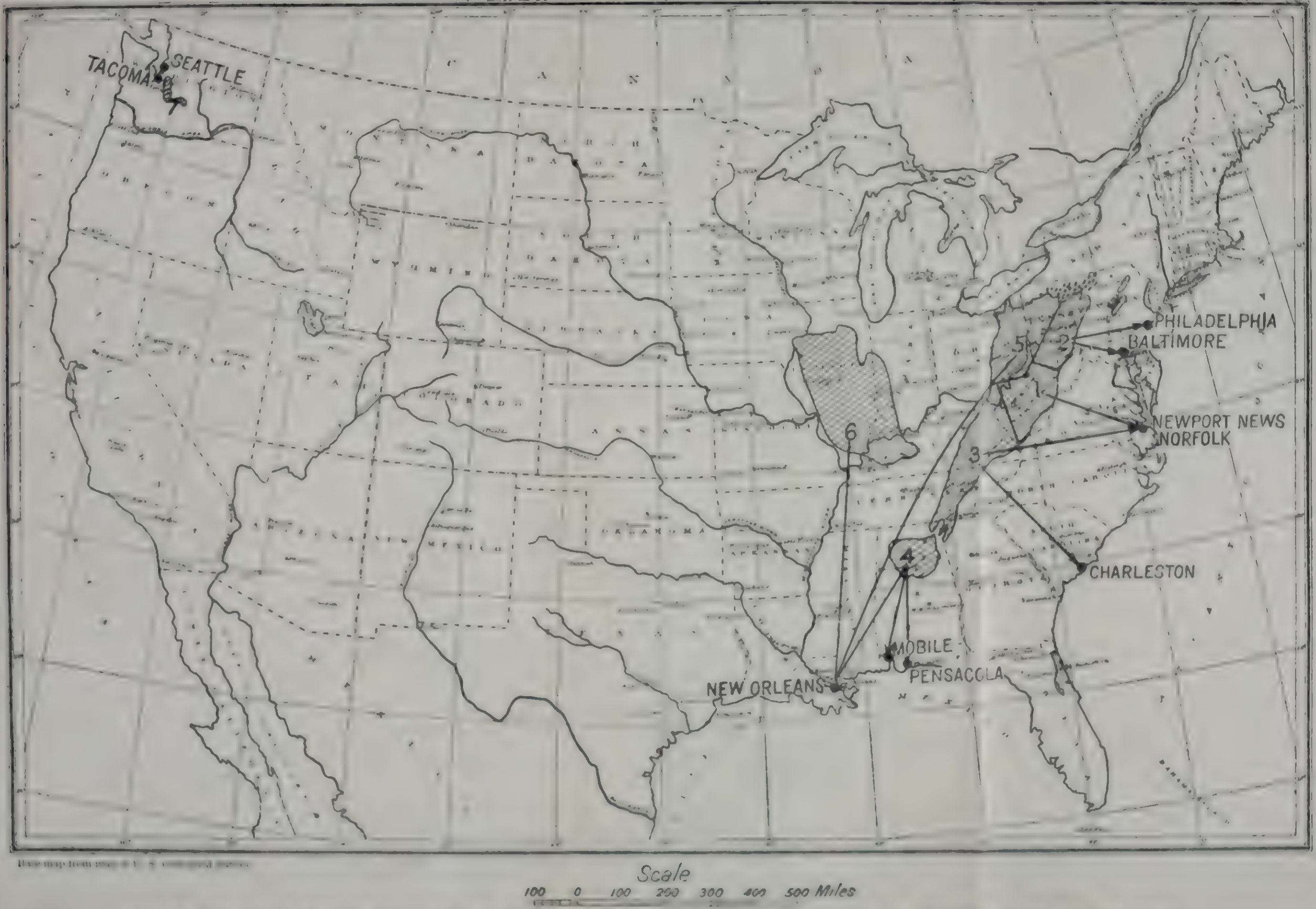
[a] Lord, N. W., Holmes, J. A., Stanton, F. M., Fieldner, A. C., and Sanford, Samuel, Analyses of coals in the United States, with descriptions of mine and field samples collected between July 1, 1904, and June 30, 1910: Bull. 22, Bureau of Mines, 1912, 1200 pp., in two parts.

Fieldner, A. C., Smith, H. I., Fay, A. H., and Sanford, Samuel, Analyses of mine and car samples of coal collected in the fiscal years 1911 to 1913: Bull. 85, Bureau of Mines, 1914, 427 pp.



Base map from map of U. S. [illegible]

MAP OF THE UNITED STATES SHOWING FIELDS CONTAINING COAL AVAILABLE FOR EXPORT AND THE SHIPPING PORTS FOR THE FIELDS.

[illegible]

British thermal units (8,115 calories) and 7 per cent ash, but the average grade is about as follows:

Average analysis of dry New River coal.

	Per cent.
Volatile matter	19.0
Fixed carbon	76.0
Ash	5.0
	100.0
Sulphur	0.55
Moisture (coal as received)	2.50

Heat value, 14,900 B. t. u. (8,280 calories).

The excellent facilities for grading the coal at the mines permit shipments to be made of sizes from "run of mine," containing approximately 50 per cent that will pass a 1-inch bar screen, to specially prepared lump sizes.

As these coals are somewhat friable, the proportion of lump is reduced by frequent handling; nevertheless, they are considered high-grade steaming and bunker coals, and are rated as smokeless. They are used on naval vessels, are stored in quantity in numerous places in the world, and have a wide application for producing power or making metallurgical coke. They are well adapted for hand firing, or for use in mechanical equipment designed for burning a coking coal.

From Norfolk and Newport News and through New Orleans a coal containing more volatile matter and especially valuable for gas making can be obtained from the Kanawha field. This coal is much used also for locomotive and stationary-plant fuel, and in making coke. It is hard, can be screened, and stands handling well. Its composition is indicated by the following average analysis:

Analysis of dry West Virginia gas coal.

	Per cent.
Volatile matter	34.0
Fixed carbon	57.5
Ash	8.5
	100.0
Sulphur	1.5
Moisture (coal as received)	2.5

Heat value, 14,000 B. t. u. (7,780 calories.)

The heating values vary between 13,750 and 14,300 British thermal units (7,640 and 7,945 calories), and the corresponding ash contents are 10 to 6.5 per cent.

GROUP 2. NORTHERN WEST VIRGINIA, MARYLAND, AND PENNSYLVANIA COALS.

SHIPPING PORTS: BALTIMORE OR PHILADELPHIA.

The coals mined in Maryland and in some of the West Virginia and Pennsylvania fields are exported either through Baltimore, Md., or

Philadelphia, Pa., at both of which places are excellent facilities for loading. Transportation from the mines to tidewater is provided by three railroad systems equipped for handling large tonnages. The coals from these fields differ considerably in volatile matter. The low-volatile coals may be represented by the following analysis:

Typical analysis of low-volatile coals.

	Per cent.
Volatile matter	19.0
Fixed carbon	73.0
Ash	8.0
	100.0
Sulphur	1.25
Moisture (coal as received)	2.50

Heat value, 14,350 B. t. u. (7,975 calories).

Shipments of coal from the different mines in this field may range in heating value from 14,000 to 14,650 British thermal units (7,780 to 8,140 calories) and in ash content from 6 to 10 per cent. These coals resemble in character the coals of Group 1, and are used for similar purposes. They are especially in demand for steam production and bunker use because of the lower proportion of volatile matter. Their heating value is somewhat less than that of the coals of the first group, but they are also less friable.

The fields produce coals having a higher content of volatile matter, as shown by the following representative analysis:

Typical analysis of coals of medium volatile matter.

	Per cent.
Volatile matter	28.0
Fixed carbon	64.0
Ash	8.0
	100.0
Sulphur	0.7
Moisture (coal as received)	2.5

Heat value, 14,250 B. t. u. (7,920 calories).

The heating value of these coals may be expected to range from 13,950 British thermal units to 14,550 British thermal units (7,750 to 8,085 calories) and the ash content from 6 to 10 per cent. Because of their relative hardness, the coals may be readily graded into various sizes and delivered on ship with comparatively little breakage.

These coals are much used in making coke and illuminating gas. They are also excellent steaming coals and are used extensively on locomotives and at manufacturing plants. Although in ordinary hand-fired furnaces these coals make smoke, they are burned smokelessly with mechanical stokers.

From the Fairmont district in northern West Virginia and from the Connellsville, Pittsburgh, and Westmoreland districts in Pennsylvania (lying along the arbitrary boundary line between Groups

2 and 5—see Pl. 1), coals are produced containing a greater proportion of volatile matter than in the coals just above. These coals are especially valuable for gas making and coking, and they are used in industrial steam plants and locomotives, and with special equipment they can be burned smokelessly. They are likewise hard and can be readily screened and delivered on ships with comparatively little breakage. Their composition is indicated by the following analysis:

Typical analysis of coals high in volatile matter.

	Per cent.
Volatile matter	37.0
Fixed carbon	55.0
Ash	8.0
	100.0
Sulphur	1.25
Moisture (coal as received)	2.5

Heat value, 14,000 B. t. u. (7,780 calories).

Some of these coals may range in heating value from 13.600 British thermal units to 14,250 British thermal units (7,556 to 7,917 calories) and in ash content from 6 to 10 per cent.

GROUP 3. VIRGINIA, KENTUCKY, AND TENNESSEE COALS.

SHIPPING PORTS: NORFOLK, NEWPORT NEWS, OR CHARLESTON.

Export shipments of the coals of Group 3 are loaded at either Norfolk or Newport News, Va., or Charleston, S. C. Transportation from the mines to the coast is furnished by three railroad systems equipped for handling heavy traffic.

The composition and heating value of these coals vary somewhat more than those of some of the other coals described, but the analysis given below is a fair average for the coals of the group:

Average analysis of dry coal from Group 3.

	Per cent.
Volatile matter	35.0
Fixed carbon	56.5
Ash	8.5
	100.0
Sulphur	0.7
Moisture (coal as received)	2.5

Heat value, 14,100 B. t. u. (7,835 calories).

Some deliveries of these coals may show an ash content as low as 6 per cent and a heat value of 14,450 British thermal units (8.030 calories), whereas others may show 10.5 per cent ash and a heat value of 13,800 British thermal units (7,670 calories).

The coals of Group 3 are comparatively hard and lumpy, and deliveries can therefore be made containing large percentages of lump. Because of their high content of volatile matter, however, the coals are difficult to burn in ordinary hand-fired furnaces without smoke, although some mechanical stokers burn them smokelessly. The coals are primarily steam coals, and a large tonnage is supplied annually to the railroads for locomotive fuel. They are also used extensively in a great variety of industrial plants.

GROUP 4. ALABAMA COALS.

SHIPPING PORTS: MOBILE, NEW ORLEANS, OR PENSACOLA.

Most of the coal produced in Alabama at present is used in near-by territory, but shipments for export may be made through Mobile, Ala., New Orleans, La., or Pensacola, Fla., by three railroad systems which enter the field. All of these ports have facilities for loading coal.

The chemical composition of Alabama coals varies considerably, but the following analysis shows the general type:

Analysis of general type of Alabama coal.

	Per cent.
Volatile matter	34.0
Fixed carbon	59.0
Ash	7.0
	100.0
Sulphur	1.0
Moisture (coal as received)	2.5

Heat value, 14,050 B. t. u. (7,805 calories).

Some coal may contain 5 to 10 per cent of ash and range in heat value from 13,600 to 14,350 British thermal units (7,560 to 7,975 calories).

Alabama coal is hard, screens well, and burns rapidly. It is especially adapted to manufacturing and railroad use, but is used extensively for making coke. The great iron and steel industries of the Birmingham district depend on this field for their fuel.

GROUP 5. WESTERN PENNSYLVANIA COALS.

SHIPPING PORT: NEW ORLEANS.

Group 5 embraces that part of the Pennsylvania coal field from which coal can be sent by barges down the Ohio and Mississippi Rivers to New Orleans, La. A large amount of this coal is shipped a long distance by rail and boat to points on the Great Lakes. Its hard and firm character enables it to withstand screening and transportation well. The coals include some of the best steam and gas coals, among them the coals upon which the great industries of the manufacturing district around Pittsburgh, Pa., depend. They are used extensively for generating steam on locomotives and at industrial plants and for making coke. With special equipment they can be burned smokelessly. The following is a typical analysis:

Typical analysis of western Pennsylvania coal.

	Per cent.
Volatile matter	35.0
Fixed carbon	55.5
Ash	9.5
	100.0
Sulphur	1.25
Moisture (coal as received)	4.0

Heat value, 13,650 B. t. u. (7,585 calories).

GROUP 6. ILLINOIS AND INDIANA COALS.

SHIPPING PORT: NEW ORLEANS.

By reason of the situation of part of the Illinois-Indiana coal field, coals for export can be shipped by barges down the Mississippi River system to New Orleans, La. The character of these coals is shown by the following typical analysis:

Typical analysis of coal from the Illinois-Indiana field.

	Per cent.
Volatile matter	38.0
Fixed carbon	53.0
Ash	9.0
	100.0
Sulphur	2.0
Moisture (coal as received)	8.0

Heat value, 13,000 B. t. u. (7,225 calories).

The coals of Group 6 are used extensively throughout the central United States for steam production. Some of the output is used for making illuminating gas.

GROUP 7. WASHINGTON COALS.

SHIPPING PORTS: TACOMA AND SEATTLE.

Group 7 includes the coals mined in the extreme northwestern part of the United States. These are practically the only United States coals mined near the Pacific coast. Tacoma and Seattle, Wash., are the tidewater shipping ports.

In these as in other fields there is wide variation in the quality of the coals mined. The fuels available for export, however, may be represented by the two typical analyses given below.

Analysis of dry coal from Pierce County, Wash.

	Per cent.
Volatile matter	40.0
Fixed carbon	49.0
Ash	11.0
	100.0
Sulphur	0.9
Moisture (coal as received)	3.0

Heat value, 13,350 B. t. u. (7,420 calories).

Analysis of dry coal from King County, Wash.

	Per cent.
Volatile matter	41.0
Fixed carbon	47.0
Ash	12.0
	100.0
Sulphur	0.8
Moisture (coal as received)	9.0

Heat value, 12,400 B. t. u. (6,890 calories).

Some of the coals show a heating value of 12,770 British thermal units (7,095 calories) and contain 9 per cent ash.

The coals from Group 7 are rather friable and are used chiefly for locomotive fuel, for domestic purposes, and in stationary and marine boiler plants.

SPECIAL SHIPMENTS.

The reader should note that the analyses published in this paper represent average shipments of large quantities of coal. Producers in all the fields can ship coal of better grade when specially prepared coal is requested.

PUBLICATIONS ON FUEL TECHNOLOGY.

A limited supply of the following publications of the Bureau of Mines is temporarily available for free distribution. Requests for all publications can not be granted, and applicants should limit their selection to publications that may be of especial interest to them. Requests for publications should be addressed to the Director, Bureau of Mines, Washington, D. C.:

BULLETIN 2. North Dakota lignite as a fuel for power-plant boilers, by D. T. Randall and Henry Kreisinger. 1910. 42 pp., 1 pl., 7 figs.

BULLETIN 4. Features of producer-gas power-plant development in Europe, by R. H. Fernald. 1910. 27 pp., 4 pls., 7 figs.

BULLETIN 5. Washing and coking tests of coal at Denver, Colo., July 1, 1908, to June 30, 1909, by A. W. Belden, G. R. Delamater, J. J. Groves, and K. M. Way. 1910. 62 pp., 1 fig.

BULLETIN 6. Coals available for the manufacture of illuminating gas, by A. H. White and Perry Barker, compiled and revised by H. M. Wilson. 1911. 77 pp., 4 pls., 12 figs.

BULLETIN 13. Résumé of producer-gas investigations, October 1, 1904, to June 30, 1910, by R. H. Fernald and C. D. Smith. 1911. 393 pp., 12 pls., 250 figs.

BULLETIN 14. Briquetting tests of lignite at Pittsburgh, Pa., 1908–9; with a chapter on sulphite-pitch binder, by C. L. Wright. 1911. 64 pp., 11 pls., 4 figs.

BULLETIN 16. The uses of peat for fuel and other purposes, by C. A. Davis. 1911. 214 pp., 1 pl., 1 fig.

BULLETIN 18. The transmission of heat into steam boilers, by Henry Kreisinger and W. T. Ray. 1912. 180 pp., 78 figs.

BULLETIN 24. Binders for coal briquets, by J. E. Mills. 56 pp., 1 fig. Reprint of United States Geological Survey Bulletin 343.

Bulletin 27. Tests of coal and briquets as fuel for house-heating boilers, by D. T. Randall. 44 pp., 3 pls., 2 figs. Reprint of United States Geological Survey Bulletin 366.

Bulletin 28. Experimental work conducted in the chemical laboratory of the United States fuel-testing plant at St. Louis, Mo., January 1, 1905, to July 31, 1906, by N. W. Lord. 51 pp. Reprint of United States Geological Survey Bulletin 323.

Bulletin 31. Incidental problems in gas-producer tests, by R. H. Fernald, C. D. Smith, J. K. Clement, and H. A. Grine. 29 pp., 8 figs. Reprint of United States Geological Survey Bulletin 393.

Bulletin 32. Commercial deductions from comparisons of gasoline and alcohol tests of internal-combustion engines, by R. M. Strong. 38 pp. Reprint of United States Geological Survey Bulletin 392.

Bulletin 33. Comparative tests of run-of-mine and briquetted coal on the torpedo boat *Biddle*, by W. T. Ray and Henry Kreisinger. 50 pp., 10 figs. Reprint of United States Geological Survey Bulletin 403.

Bulletin 34. Tests of run-of-mine and briquetted coal in a locomotive boiler, by W. T. Ray and Henry Kreisinger. 33 pp., 9 figs. Reprint of United States Geological Survey Bulletin 412.

Bulletin 35. The utilization of fuel in locomotive practice, by W. F. M. Goss. 29 pp., 8 figs. Reprint of United States Geological Survey Bulletin 402.

Bulletin 36. Alaskan coal problems, by W. L. Fisher. 1911. 32 pp., 1 pl.

Bulletin 39. The smoke problem at boiler plants, a preliminary report, by D. T. Randall. 31 pp. Reprint of United States Geological Survey Bulletin 334, revised by S. B. Flagg.

Bulletin 40. The smokeless combustion of coal in boiler furnaces, with a chapter on central heating plants, by D. T. Randall and H. W. Weeks. 188 pp., 40 figs. Reprint of United States Geological Survey Bulletin 373, revised by Henry Kreisinger.

Bulletin 49. City smoke ordinances and smoke abatement, by S. B. Flagg. 1912. 55 pp.

Bulletin 54. Foundry cupola gases and temperatures, by A. W. Belden. 1913. 29 pp., 3 pls., 16 figs.

Bulletin 55. The commercial trend of the producer-gas power plant in the United States, by R. H. Fernald. 1913. 93 pp., 1 pl., 4 figs.

Bulletin 56. First series of coal-dust tests in the experimental mine, by G. S. Rice, L. M. Jones, J. K. Clement, and W. L. Egy. 1913. 115 pp., 12 pls., 28 figs.

Bulletin 58. Fuel-briquetting investigations, July, 1904, to July, 1912, by C. L. Wright. 1913. 277 pp., 21 pls., 3 figs.

Bulletin 97. Sampling and analyzing flue gases, by Henry Kreisinger and F. K. Ovitz. 1915. 70 pp., 1 pl., 36 figs.

Bulletin 116. Methods of sampling delivered coal, and specifications for the purchase of coal for the Government, by G. S. Pope. 1916. 64 pp., 5 pls., 2 figs.

Technical Paper 2. The escape of gas from coal, by H. C. Porter and H. C. Ovitz. 1911. 14 pp., 1 fig.

Technical Paper 3. Specifications for the purchase of fuel oil for the Government, with directions for sampling oil and natural gas, by I. C. Allen. 1911. 13 pp.

Technical Paper 5. The constituents of coal soluble in phenol, by J. C. W. Frazer and E. J. Hoffman. 1912. 20 pp., 1 pl.

Technical Paper 8. Methods of analyzing coal and coke, by F. M. Stanton and A. C. Fieldner. 1913. 42 pp., 12 figs.

Technical Paper 10. Liquefied products of natural gas; their properties and uses, by I. C. Allen and G. A. Burrell. 1912. 23 pp.

Technical Paper 16. Deterioration and spontaneous combustion of coal in storage, a preliminary report, by H. C. Porter and F. K. Ovitz. 1912. 14 pp.

Technical Paper 25. Methods for the determination of water in petroleum and its products, by I. C. Allen and W. A. Jacobs. 1912. 13 pp., 2 figs.

Technical Paper 34. Experiments with furnaces for a hand-fired return tubular boiler, by S. B. Flagg, G. C. Cook, and F. E. Woodman. 1914. 32 pp., 1 pl., 4 figs.

Technical Paper 35. Weathering of the Pittsburgh coal bed at the experimental mine near Bruceton, Pa., by H. C. Porter and A. C. Fieldner. 1914. 35 pp., 14 figs.

Technical Paper 37. Heavy oil as fuel for internal-combustion engines, by I. C. Allen. 1913. 36 pp.

Technical Paper 38. Wastes in the production and utilization of natural gas, and methods for their prevention, by Ralph Arnold and F. G. Clapp. 1913. 29 pp.

Technical Paper 45. Waste of oil and gas in the Mid-Continent fields, by R. S. Blatchley. 1914. 54 pp., 2 pls., 15 figs.

Technical Paper 49. The flash point of oils; methods, and apparatus for its determination, by I. C. Allen and A. S. Crossfield. 1913. 31 pp., 2 figs.

Technical Paper 50. Metallurgical coke, by A. W. Belden. 1913. 48 pp., 1 pl., 23 figs.

Technical Paper 55. The production and use of brown coal in the vicinity of Cologne, Germany, by C. A. Davis. 1913. 15 pp.

Technical Paper 57. A preliminary report on the utilization of petroleum and natural gas in Wyoming, by W. R. Calvert, with a discussion of the suitability of natural gas for making gasoline, by G. A. Burrell. 1913. 23 pp.

Technical Paper 63. Factors governing the combustion of coal in boiler furnaces; a preliminary report, by J. K. Clement, J. C. W. Frazer, and C. E. Augustine. 1914. 46 pp., 26 figs.

Technical Paper 65. A study of the oxidation of coal, by H. C. Porter. 1914. 30 pp., 12 figs.

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